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GIFTED STUDENTS' PERCEPTIONS ON SCIENCE COURSES IN GENERAL EDUCATION CLASSROOM

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Abstract. *Gifted students often experience different educational needs compared to their peers, especially in subjects like science. The aim of this study was to examine the perceptions of gifted students studying in primary school towards the science course. A phenomenological research method was used. The study group consisted of twenty-four gifted students aged 9–10 years studying in eleven different primary schools in a province in southeastern Türkiye during the 2023-2024 academic year. Data were collected through semi-structured interviews, which were conducted face-to-face. The data were analyzed using content analysis in the MAXQDA 24 software. Gifted students show a strong interest in astronomy, earth sciences, and chemistry, while their interest in other scientific fields, such as biology, is limited. They reported that science lessons often use teacher-centered, text-based approaches that offer limited technology active learning. Although science education at the Science and Art Center was satisfactory, the students expressed that regular classroom practices did not meet their expectations. Students emphasized the need for innovative teaching methods, active learning, laboratory activities, and outdoor learning opportunities. The findings indicate that teaching methods need to be improved, and student-centered approaches can enhance course quality and increase student motivation.*
Keywords: *gifted children, primary schools, qualitative approach, science courses*

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Introduction

Countries globally acknowledge the vital importance of education for national power and competitiveness. Substantial endeavors are underway in theoretical, applied, and policy research to cultivate gifted students across all disciplines. Countries allocate significant resources to invest in education and select students with extraordinary qualities who can benefit society. A range of programs is implemented to optimize the potential of these students. This educational strategy has emerged as a global priority. In Türkiye, Science and Art Centers (BILSEM) were founded in 2004, primarily in provincial centers, to implement enrichment programs that foster the scientific, artistic, social, and cultural growth of outstanding pupils. The implementation of an alternative enrichment program for gifted students constituted a positive development (Bildiren & Citil, 2021). Gifted individuals exist who are unable to participate in BILSEM programs due to factors such as transportation issues and difficulty with the identification process. They continue their education in conventional schools. In light of these deficiencies, the General Directorate of Special Education and Guidance Services established support education rooms in 2012 and executed several initiatives to cultivate the interests and skills of gifted students.

Countries have allocated special budgets and funds to the education of gifted students, aiming to maximize their talents and skills. These efforts have led to significant progress in national policies and transformations in education systems. Education programs aim to enable gifted students to realize their potential and progress in their areas of talent, taking into account individual differences (Reis & Renzulli, 2023; VanTassel-Baska & Wood, 2010). Curriculum differentiation, enrichment, acceleration, and rigor are the most prominent methods. These methods aim to address the cognitive and creative capacities of gifted students (Renzulli et al., 2010). In addition, strategies such as cooperative learning and flexible grouping are frequently used to support students' social and emotional development (Renzulli, 2012). Such practices not only increase academic achievement, but also improve students' critical thinking, problem solving and creative thinking skills (McCarthy, 2017). The programs emphasize the special educational needs of gifted students, supporting their self-actualization and progress in various areas of talent (Olszewski-Kubilius et al., 2024). In 1997, a document published by the NDE

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stated that "*the legal requirements for gifted education include accelerated learning, assignments and/or enrichment activities that are appropriate to students' abilities regardless of age or grade"* (p.56-57) and that changes to the existing curriculum were needed. The need for an in-depth and integrated process of exploration that goes beyond the curriculum in various programs is emphasized. This necessity has led to a diversity of practices across countries, as each education system is shaped by its own cultural context and educational policies. This diversity has therefore allowed for the sharing of best practices across the world, leading to enhanced support for gifted students.

Gifted Students and Science Education

From the earliest times, people have asked questions to understand nature and the universe: What is nature? How do natural phenomena occur? What is the origin of the universe? What paths should we follow to survive? These questions have formed the cornerstones of scientific thinking and have led people to develop research methods, problem-solving strategies and logical ways of thinking. Science, as part of this intellectual process, includes scientific tools such as induction, deduction, principles, laws and theories, and informs and deeply shapes many disciplines such as physics, chemistry, biology, astronomy, and Earth sciences (Tobin, 2016). While science is defined as the human endeavor to better know, recognize and make sense of the world (Zacharia, 2003), Thonney and Farrell (1995) have defined science as a systematic approach to understanding nature through observing, making inferences, testing ideas and using scientific thinking processes. Science covers a wide area, with an integrated structure that interacts with other fields (Tytler et al., 2021; Shaffer, 2011). This holistic structure shapes the purpose of science education aiming to raise science literate individuals who learn methods of scientific thinking, question and contribute to society with rational decisions (Holbrook & Rannikmae, 2007). Science teaching emphasizes skills such as predicting, observing, researching, hypothesizing and testing, and interpreting data to develop scientific process skills. Inquiry-based practices are frequently recommended to develop these skills, enabling students to develop scientific thinking while actively participating. Science education especially for gifted students, should provide environments that foster their creative and analytical thinking skills by presenting in-depth and complex problems. Gifted individuals need opportunities for higher levels of inquiry, discovery and innovative solutions. In this context, the potential of gifted students is maximized by implementing enriched programs and projects in science education (Park & Oliver, 2009; Winebrenner, 2000). In science curricula developed for gifted students, the importance of talent and career development activities is emphasized, innovative methods such as problem-based learning, STEM applications, blended learning, and flipped learning come to the fore (Nacaroglu & Bektas, 2023; Ozkan & Kettler, 2022; Robinson et al., 2014; Sternberg et al., 2022; Ulger & Cepni, 2020). Experts continue to work on integrating technology and artificial intelligence into gifted education and expanding their applications (Chen et al., 2013; David et al., 2023). Research has demonstrated the benefits of deepening activities with interdisciplinary studies, and integration models such as the engineering design cycle and STEM applications have been proposed (Bryan et al., 2016; Ouyang, & Xu, 2024; Sapounidis et al., 2024; Zhou et al., 2023). As a result, studies aim to ensure that gifted students progress not only cognitively in science but also in developing their non-cognitive characteristics (Olszewski-Kubilius, & Thomson, 2015; Renzulli, 2012).

There is a widespread view that standard science education practices do not provide an adequate foundation for gifted students to succeed in their areas of strength, enabling them to develop new skills (Taber, 2014). "*Flow*" is defined as a state in which these students are deeply focused on a task, forgetting the passage of time and thus being fully engaged. However, the extent to which this state of flow is experienced by gifted students in response to the requirements of the standard curriculum is still a matter of debate. While some experts argue that the traditional curriculum does not fully address the potential of these students and does not meet their need for deeper exploration (Bernal, 2003), others have explored how the curriculum can be adapted to their needs (Kaplan, 2009; Vantassel-Baska & Wood, 2010). Research shows that gifted individuals come to science classes more cognitively, affectively, and psychomotor ready than their peers (Gould et al., 2003; Ngoi & Vodracek, 2004; Tomlinson, 2001). Camcı Erdogan (2014) emphasized that gifted students have different characteristics in terms of interest, motivation, comprehension, and scientific inquiry, and that science teaching should be differentiated based on these characteristics. Differentiated science curriculum refers to the changes made to the content, process, learning products and environments in the science curriculum (Tomlinson, 2001). This type of curriculum provides more challenging, complex, and in-depth problem-solving opportunities for gifted students. For example, the science curriculum can be differentiated using the depth and complexity guidelines in the Grid model (Kaplan, 2009). This model encourages the effective use of higher order thinking skills by increasing the challenge of the content in the curriculum (Kaplan, 2009; Dodds, 2010). It also contributes to teachers' professional development by facilitating

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interdisciplinary connections and knowledge transfer in the curriculum (Grubb, 2011). It is also important to use universal themes in different areas and to broaden the scope of the curriculum to develop 21st century skills (Lauer, 2010; Park, 2008). For example, Kutlu Abu (2018) found that by differentiating the light and sound unit at the primary school level according to the theme of change and the Grid model's guidelines, this approach improved the self-regulation skills of gifted and other students. Camcı Erdoğan and Kahveci (2015) found that differentiating the Earth-Sun-Moon unit with the Parallel Curriculum Model and the Grid Model positively improved the attitudes of gifted middle school students towards science. The findings show that a differentiated science curriculum develops gifted students' interest and skills in science and enables them to learn more deeply.

In the literature, studies sampling gifted students have examined their perceptions across different educational practices and contexts. For example, black students' views on school (Ford & Harris, 1996), gifted students' views on summer programs and social support programs (Lee et al., 2015), perceptions of full-time grouping practices (Patry et al., 2001), and views on special classes (Vogl & Preckel, 2014) were examined. Simensen and Olsen (2024) stated that learning materials, activities, and peer interaction are limited in gifted students' mathematics classes and advanced needs are not met. Studies examining perceptions about science, on the other hand, usually involve gifted students at the middle or high school level (Ugulu, 2020). For example, Shin and Choi (2020) examined gifted middle school students' perceptions of the science curriculum and found that lessons using the science writing method had positive effects on inquiry, knowledge acquisition, learning enjoyment, and usefulness. However, studies show that the attitudes of gifted students towards science courses become less positive as they advance to higher grades (Egalite & Kisida, 2018; Swiatek & Lupkowski-Shoplik, 2000). Karnes and Riley (2005) stated that gifted students have a deep curiosity about science and enjoy problem-solving activities instead of repetition in lessons. In addition, gifted students dislike overgeneralized explanations and a lack of sufficient detail in science lessons (Han, 2007). Other studies have shown that gifted students find science lessons interesting and fun (Yang & Park, 2015). Gifted students, especially at the primary school level, generally have positive perceptions of science lessons. They have enthusiasm for science, show interest in science careers, and appreciate the social impact of science more than their average peers (Caleon & Subramaniam, 2008; Barrington & Hendricks, 1988). In addition, these students like to act like scientists, participate in group activities, and further explore challenging topics (Yang et al., 2014). They believe that science plays an important role in making the world a better place and improving living standards (Vitale & Johnson, 1988). Gifted students generally have a more positive attitude towards science and see science as an effective tool for improving the world and solving everyday problems (Sheldrake et al., 2017). However, the fact that gifted students have to live with this label, are in constant competition and face challenging tasks such as those in gifted education can sometimes negatively affect their attitudes towards science (Sak et al., 2015; Ugulu, 2020).

Studies have examined the perceptions of gifted students at the middle and high school levels on various topics such as perfectionism, mood, and multiple intelligences (Albright & Montgomery, 2023; Makkonen et al., 2022; Margot & Rinn, 2016; Milic & Simeunovic, 2024; Mofield & Peters, 2019; Portešová & Urbánek, 2013; Voitova et al., 2025). However, there is limited research on gifted students' perceptions of science courses at the elementary school level (Yang & Park, 2015). For example, Yang and Park (2015) examined gifted students' perceptions of laboratory-based science practices in elementary schools. The study found that students considered science lessons interesting. Teachers tended to recognize learning problems based on textbooks and general presentations. However, students wanted to learn by discussing learning problems directly during the experiment design phase. Urek and Dolu (2013) found that gifted students in grades 4 through 8 showed more interest in science than non-gifted students and that gifted girls were more interested in science than gifted boys and non-gifted girls. Ozdemir and Topalsan (2022) defined the metaphorical perceptions of gifted students regarding the science course as "positive", "association", and "challenging level". Akdag and Koksal (2022) found that eighth grade gifted students had high intrinsic motivation toward science. Koksal (2013) on the other hand, found that gifted students in the ninth grade had positive attitudes and motivation towards science.

Purpose and Importance

Addressing school experiences is an important issue in the multifaceted support of gifted students (Kang & Chung, 2012). School experiences provide information about various factors such as students' knowledge, perceptions, observations, practices and emotions. Therefore, identifying students' school experiences makes it

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possible to design enriched educational opportunities for their individual needs. Moreover, these experiences help educators understand the educational needs of gifted students and identify the challenges they face in the educational process. In the literature, gifted students' experiences are often limited to specialized courses, practices or curricular models. For example, middle and high school gifted students' experiences and perceptions of the Advanced International Certificate of Education (Hudson, 2019), University-Based Applications (Kang & Chung, 2012), the Gifted Program (Kitsantas et al., 2017), the Multidimensional Curriculum Models (Vidergor, 2020), and the "On-Going Topics" course (Patry et al., 2001) have been examined. However, studies on the school experiences of gifted students at the primary school level in regular schools are limited.

In particular, science-related experiences allow gifted students to develop in-depth research, inquiry and analytical thinking skills. In the literature, science-related experiences of gifted middle school students have been examined in special programs such as ASEAN +3 Junior Science Odyssey (Shin & Lee, 2023) and general programs (Kim et al., 2021). In addition, the experiences and skills of gifted students in STEM, as well as differentiation practices, and laboratory-based practices, have also been investigated (Kulegel & Topsakal, 2021; Park & Leon, 2011; Yang & Park, 2015). Koksal (2013) compared the motivation and attitudes of gifted and advanced gifted secondary schools towards learning science. There are few studies on the experiences of gifted students in regular primary classrooms in science courses. There is a need for an in-depth analysis of gifted students' conceptual perceptions of the science course in elementary schools, including their views on the methods, techniques, and practices used in the course. The aim of this study was to determine the perceptions of gifted students at the primary school level, regarding the science course. Gifted students' perceptions of science lessons in primary schools contribute to understanding the educational needs and developing teaching strategies. These insights can help design individualized and effective approaches to science education by providing information about how students approach lessons, the challenges they face and their learning styles. It can also provide guidance for diversifying teaching methods and making the best use of students' potential. The research sought to answer the following questions:

1. What are the conceptual perspectives of gifted primary school students about science courses?
2. What do gifted students think about the methods, techniques and practices used in science courses?
3. What are the difficulties that gifted primary school students experience in science courses?

Research Methodology

General Background

In this study, phenomenological research method was used to examine the perceptions of gifted students about science lessons. The main purpose of qualitative research is to describe in depth the experiences, feelings, thoughts, and meanings of individuals or groups rather than making generalizations about the population (Creswell 1998; Koopman, 2017; Merriam, 1998). The study aimed to understand the individual perceptions and experiences of gifted students about science lessons, and these experiences were described uniquely and in detail. In this context, the aim of the study is to contribute to the educational and curriculum development processes by examining the perceptions, feelings and thoughts of the students towards the science course.

Participants

Twenty-four gifted children, aged 9-10 years, were selected from 11 different primary schools in southeastern Türkiye. They were chosen based on their willingness to participate in the study, and parental permission was also obtained. Of these children, 9 are boys and 15 are girls, and all of them benefit from the support provided by BILSEM in addition to their regular schools. BILSEM offers special education programs, activities and resources aimed at maximizing the potential of gifted individuals. In the study, there are two main criteria for selecting participants: (i) attending primary school and (ii) being diagnosed as gifted. In this study, a criterion-based sampling method was used. Gifted students attending primary school have various strengths such as playing the piano, playing basketball, tennis and volleyball, painting, playing chess, experimenting, memorizing, and speaking English fluently. On the other hand, these students also have some weaknesses such as time management, study habits and social-emotional difficulties.

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Context

In the Turkish education system, gifted students are identified based on the recommendations of teachers and the evaluations of provincial and school guidance commissions. Students are examined using intelligence tests (general intellectual ability, art, music, etc.). These assessments are based on standardized test scores that take into account students' general intellectual abilities as well as their potential in special talent areas. The identification process is carried out through pre-assessment and individual tests. The students who participated in the study were those who were assessed by with the Anadolu-Sak Intelligence Scale (Sozel et al., 2018) and scored 130 or above on the IQ scale. The students included in the study were identified according to national criteria and were studying at BILSEM.

This research was conducted in a province in southeastern Türkiye with a population of approximately 300,000. Most schools in the region are public, and the province is largely rural. Rural schools may have fewer resources and infrastructure than urban schools. However, centers such as BILSEM offer an important opportunity to overcome these shortcomings. The occupations of families in this province are generally concentrated in trade, animal husbandry and the public sector (teaching, health, security). The economic situation of the students' families is good, and their educational attainment level is such that most have completed high school or university. These students are the children of families who recognize their special talents at an early age and make extra effort in this area. The gender distribution of the students was determined randomly, since student selection was based on voluntary participation.

Data Collection and Analysis

A semi-structured interview form, conducted through face-to-face interviews, was utilized as a data collection tool in this study. Semi-structured interview forms provide participants with a specific framework, while allowing them to express their thoughts more freely. This type of interview provides the opportunity to explore new themes or responses that may emerge during the research process, thus helping to obtain more comprehensive data. There are ten questions in the interview form. The questions aimed to determine the perceptions of gifted students on science lessons. Research permissions were obtained from the Ministry of National Education and the Ethics Committee for the interviews. The interviews were conducted face-to-face between 04.09.2023–and 20.09.2024. With the participants' permission, the interviews were audio-recorded, and each interview was conducted in a suitable, quiet classroom environment. Interviews were conducted on weekday afternoons according to the participants' availability, and each interview lasted approximately fifteen to twenty minutes. Participants were informed that the audio recording would be used for research purposes only. The data were analyzed using content analysis in the MAXQDA 24 program. The data obtained from the voice recordings were transcribed. The data and notes from the interviews were carefully analyzed to understand the experiences. Important meaning units in the data were coded. The themes were identified according to the similarities and differences in the codes. The analysis of themes led to different categories. Models and tables were used to represent the data.

Validity, Reliability and Ethics

In this study, various steps were taken to ensure validity and reliability. Validity was ensured through a data collection and analysis process appropriate to the purpose of the study. Face-to-face interviews were designed to understand the participants' experiences in depth, and open-ended questions were used. In this way, participants' perceptions and experiences were accurately reflected. The reliability of the data analysis was increased by calculating coder consistency. The inter-coder consistency coefficient was found to be 0.85, indicating that the consistency in the analysis process was high. In addition, the coding process was reviewed several times to ensure the accuracy of the data. Ethically, participants' rights were protected throughout the research process. Each individual participating in the study was informed about the purpose of the research and participated in the interviews on a voluntary basis. In addition, the confidentiality of the participants was protected, and the interviews were used for research purposes only. The research process was conducted in accordance with ethical rules and requirements, and the necessary permissions were obtained from the relevant institutions.

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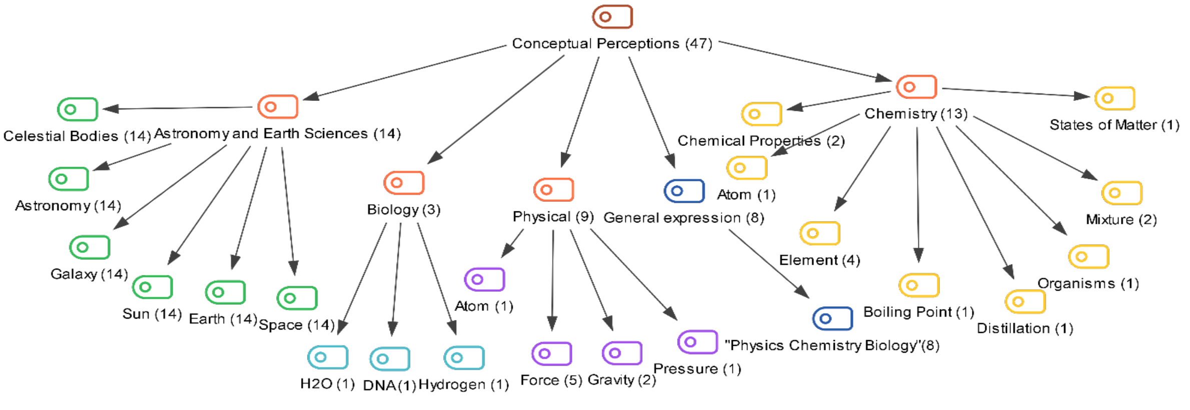
Research Results

When the research findings were evaluated holistically, four themes emerged regarding the perceptions of gifted students toward science courses. These themes are (i) conceptual perspectives of science courses, (ii) differentiated/enriched science activities, (iii) science materials and experiences, and (iv) expectations in science courses.

Conceptual Perspectives of Science

Students were first asked what concepts they associated with science. The answers given by the students were divided into two categories: basic concepts about science and sub-disciplines of science. The first basic concepts that came to their minds when science was mentioned were "*experiment, science, scientist, scientific method, invention, laboratory, microscope*". 18 gifted students repeated specifically the concept of experimentation. The discipline codes obtained when students take science courses are given in Figure 1.

Figure 1
Conceptual Perspectives of Gifted Students Towards Science



When the codes in Figure 1 were examined, 4 categories were reached: "physics, chemistry, and biology" group, astronomy sciences group, physics group, chemistry group, biology group. When the sub-codes related to the categories were examined, the frequencies within the astronomy category such as Space, Galaxies, Earth and Sun, were the highest *(f= 14)*.

> G6: [Space fascinates me and I find myself wondering about space because there is so much uncertainty. Mystery…]

There are 13 views that directly relate science to chemistry. When the subcodes of chemistry were examined, there were 9 chemistry codes, namely atom, boiling point, distillation, chemical properties, expansion, contraction, mixture and states of matter. A highly talented student, in relation to chemistry subjects, said the following:

> G16: [We conduct more chemistry experiments in applications. That's why when I think of science, I think more of chemistry.]

In the physics branch, where 9 people expressed their opinions, 4 codes were reached, namely force *(f= 5)*, gravity *(f= 2)*, atom *(f= 1)* and pressure *(f= 1)*. Three codes (DNA, H_2O, and Hydrogen) were identified in the biology branch. There are 8 talented students who can articulate the concepts of "physics, chemistry, and biology" together.

> G5: [When I think of science, I think of physics, chemistry and biology. I can't just say physics, chemistry or biology. (Why do you think so?) Because science is a big field, it is related to everything, it is hard to distinguish.]

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Differentiation/Enrichment Practices

Gifted students coded as G1, G5, G7, G8, G9, G10, G12 noted that enrichment or differentiation activities are rarely carried out in science lessons in regular schools. Many gifted students stated that enrichment/differentiation activities are conducted frequently in science classes in BILSEMs (G3, G6, G14, G17, G18, G20, G23, G24). They stated that prediction, observation, and reading activities are mostly included in regular classes. It was stated that teacher-centered and book-based experiments are conducted in science classes. They stated that materials such as beakers, water, different substances, microscopes, magnets, volumetric containers, test tubes, world models, and scales are used in teacher-centered experiments. Gifted students reported that they were not allowed to experiment on their own in regular schools and that they needed laboratories for experimentation.

> G10: [I like to do experiments, observe, and see what happens. But in science class, we listen, our teacher does not allow us to experiment on our own.]
>
> G18: [Normally, there are no different or enriched activities in the schools we go to. The teacher usually does the activities by reading from the book. They do the experiments themselves, and we watch or wait without doing anything.]
>
> G4: [I usually do research on my own to learn about the subjects.]
>
> G6: [We do research and observation.]
>
> G17: [If I know which experiment to do, I do the same experiment at home. I usually follow it from a textbook.]

While gifted students stated that different methods and techniques are frequently used in BILSEM applications when evaluating science lessons, they noted that such methods and techniques are not applied in normal classes. They stated that STEM, virtual trips, technology-based applications, artificial intelligence, coding and engineering applications are conducted in BILSEMs, and no technology-related application is conducted in normal classes.

> G13: [There is nothing related to technology in our school. There are projection devices, yes. They are only used for reflections for presentation purposes. For example, at BILSEM, we do activities such as STEM, robotic applications and engineering applications. We use computers effectively, we learn new things, such as how we can use artificial intelligence in our studies.]
>
> G22: [At BILSEMs, different applications are made in different fields such as physics, chemistry, biology, astronomy. We often do experiments. STEM applications are the applications that I enjoy working on.]

Science Materials and Experiences

Table 1 shows the coding of the most frequently used materials in science lessons and applications in experiments. Gifted students stated that they frequently used materials such as beakers, water, different substances, microscopes, magnets, volumetric flasks, test tubes, earth models and scales in science lessons. Fifteen gifted students stated that they generally followed the order in the textbook when conducting experiments. In the preparation phase of the experiments, 17 gifted students stated that teacher-centered experiments were conducted and that they participated in observation and estimation practices. Seven students reported that they searched the internet for information on the subject. The student identified as G7 stated that he did not prepare before the experiment. Student coded G7 said, "I do not prepare for the experiments because there are no difficult experiments. Experiments in schools are easier. There is no time to prepare for BILSEM experiments. I am tired when I go to BILSEM after school."

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Table 1
Experiences and Materials Used in Science Courses

Material Codes	Students	Frequency	Quotes
Water	G2*-G3-G6-G8-G9-G12-G20	7	"The most common material we use is water. We must pour it on the ground while using it. (G3)" "We made extensive use of water and glass because we are focusing on reflection. When using frosted glass, we must exercise caution because it has the potential to cut our hands... (G6)" "Different experimental materials such as beakers, heat sources, measuring tools and microscopes are generally used in experiments. (G23)"
Microscope-Slide-Coverslip	G5-G23	1	
Beaker glass,	G7-G13-G14-G15-G16-G17-G19-G20-G23-G24	10	
Magnets	G1-G18-G21	3	
Stone, sand	G13	1	
Volumetric Flask	G4-G10-G14-G23-G24	5	
Spirit Furnace	G16	1	
Earth Globe	G18	1	
Test Tube	G11-G16-G17-G21 G23-G24	3	
Scales, Thermometer	G3-G5-G6-G10-G11-G15-G16-	2	
Matters	G17-G20-G21-G22-G24	12	
Experiment Preparation Stages	**Students**	**Frequency**	**Quotes**
Not knowing which experiment to do	G7	1	"Teachers do experiments themselves, we do not. At that stage, predictions are asked through question and answer. We observe as much as we can see.. (G6)" "If I know what experiment to do, I rehearse it at home. I usually follow it from a textbook. (G18)" "I generally do research in order to gain knowledge about the subjects… (G4)"
Observation and prediction in teacher-centered experiments	G1, G6, G8, G9, G10, G12, G14, G15, G16, G17, G18, G19, G20, G21, G22, G23, G24	17	
Reading a text about the experiment	G2, G3, G4, G6, G7, G10, G11, G12, G13, G14, G15, G18, G20, G21, G22	15	
Subject search on the internet	G4, G5, G10, G16, G18, G21, G22	7	

**G=Gifted student*

Expectations in Science Course

Table 2 shows the coding of perceptions of gifted students in the science course. There are nine sub-codes related to the problems experienced in science classes. These codes are failed experiments, technical malfunctions in materials, unwanted accidents, disciplinary problems in the classroom, finishing tasks early and feeling bored, too much noise, different pursuits, lack of materials and inadequate science knowledge. G1, G3, G4, G7, G9, G14, G15, G16, and G17 stated that they experienced a lack of materials in experiments. G4, G6, G8, G11, G12, and G13 perceive the unsuccessful results in experiments as a problem. G5, G7, G9, G21, and G22 stated that the tasks given in science class were finished early and they became bored during the lesson. Students with codes G1, G3, G7, G8, G18, and G20 stated that noise and discipline problems in the classrooms hindered the effectiveness of the lesson.

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Table 2
Gifted Perceptions Towards Science Lesson

Challenges Codes	Students	Frequency	Quotes
Failed Experiments	G4-G6-G8-G11-G12-G13	6	"There are many missing materials. Our teacher assigns tasks, such as instructing us to bring specific items. Occasionally, acquaintances may also fail to remember, and there will be a substantial amount of commotion. (G3)" "Indeed, there are instances when it is necessary to emit gas, such as the release of smoke or even an explosion. However, there are occasions when these expected outcomes fail to occur. (G6)" "Lack of materials or noise in the classroom. (G1)" "It appears that maintaining focus is more difficult for distracted students, as has often been observed in educational settings. I'm constantly distracted or bored. Because we stay for a long time, the teachers frequently warn the students to pay attention, as they have difficulty staying focused. (G15)"
Technical Malfunctions in Materials	G1-G10	2	
Unwanted Accidents	G2,G24	2	
Disciplinary Problems in the Classroom	G3, G18, G20	3	
Finishing Tasks Early and Feeling Bored	G5, G7, G9,G21,G22	5	
Too much Noise	G1, G3, G7, G8	4	
Different Pursuits	G2, G5, G10	3	
Lack of Materials	G1,G3, G4,G7, G9,G14, G15,G16,G17	9	
Lack of Information	G12, G19,G23	3	
Expectations from Science Class	**Students**	**Frequency**	**Quotes**
Enriched Methods and Techniques	G1,G6,G8,G10, G15	5	"I would like some topics, especially complex and challenging ones like force and motion, to be presented in a more comprehensive way. I would like to see activities where we are personally active to make hypotheses and design experiments, and make predictions. Not only I but also my classmates can become individually active. (G3)" "There is a lack of integration with technology in science classes. The use of different multimedia tools is not sufficient. (G14)"
Active Learning	G2, G3, G9, G12, G16,G20,G22	7	
Technology Integration	G4,G13,G14,G19,G23	5	
Cognitive-Social Activity/Outdoor Learning	G5-G7-G9,G18,G21,G24	6	
Student-centered Experiments	G3, G6, G11,G17	3	

When the given answers were examined, most of the students reported that science lessons should be based on active learning (f= 7), and should be supported with activities focused on skill development, including cognitive and social activities (f = 6). They interpreted an increase in the number of cognitive and social activities (outside school learning) in science lessons as an important factor in their self-actualization. G21 said, "For example, I am interested in birds. I like to read about this subject. There are no social practices in schools. We should go birdwatching, get together with friends, and go on a trip." G24 said, "Sometimes it would be great to have a trip outside school focused on science subjects and research design. It would be useful if our observations were related to real life, and we could work with our friends. What would be the benefit? We would understand difficult subjects better. We would have the opportunity to do research in different places." The opinions highlighted the importance of integrating science lessons with technology and multimedia tools. G13 said, "Only presentations are used for the subjects we study in science classes. Interactive, technology-based applications are not implemented in normal schools. When we come to BILSEM, we can encounter different applications such as coding." Regarding these views, student-centered activities should be implemented in science applications and the use of enriched methods and techniques should be increased. G10 said, "We should do experiments ourselves and undertake projects. We do projects. For example, I went to courses: STEM and robotic coding. We can engage in activities like these."

Discussion

In this study, the perceptions of gifted students in primary schools towards science courses were examined in depth. The research themes are a conceptual perspective of the science course, differentiated/enriched science

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activities, science materials and experiences, and expectations from the science course. Most gifted students associate the concept of science with astronomy and Earth sciences. They stated that they have special interests in space, galaxies, Earth, Sun and celestial bodies. When the relevant literature is examined, it reveals that gifted children have a high interest in astronomy and earth sciences and enjoy doing research and reading on these subjects (Onal & Onal, 2021). Karabulut (2014) reported that gifted individuals have been studying astronomy and earth sciences from the past to the present, that they have special interests and that these subjects are given two hours per week in science high schools. Although astronomy and earth sciences are the oldest sciences that enable people to understand their place in the universe and the natural events happening around them, they are underrepresented in the broader context of contemporary sciences (Trumper, 2006). Many laws taught in school courses naturally apply to universal phenomena, illustrating their broad applicability. It is the duty of astronomers to understand and interpret the functioning of this laboratory (Hudgins, et al., 2006). Therefore, it is considered beneficial that gifted students have an interest in this field of science. The reason for this finding may be that there are many uncertainties and mysteries related to astronomy and earth sciences, the desire to discover these subjects may have attracted students to explore these fields. In addition, situations such as talking about astronomy with family and peers and the emphasis on astronomy in science fiction movies may have increased the interest of gifted students in astronomy and earth sciences (Richards & Kelly, 2024; Susman & Pavlin, 2020). Subası et al. (2015) conducted a study on the perspectives of gifted students on astronomy and space sciences. In this study, they found that the disciplines of astronomy and Earth Sciences generally involve the use of hypothetical thinking and analytical thinking. Studies have shown that the use of augmented virtual reality technologies increases students' interest in and attitudes towards astronomy concepts (Onal & Onal, 2021; Aktas, 2023).

When science was mentioned, most gifted students first associated it with astronomy, although more subcodes focused on chemistry. When the subcodes were examined, there were fourteen codes for astronomy and thirteen codes for chemistry. The findings show that gifted students associated the science course more with their experiences in chemistry. This may indicate that applications related to chemistry were carried out more often in science courses. Indeed, the student with the code G16 stated that chemistry experiments were frequently carried out and that he directly associated chemistry with science courses. Based on the findings, most of the gifted students were interested in astronomy and earth sciences, but they perceived that chemistry applications were carried out more in normal classes. Indeed, when asked which materials were used in science courses, most students reported that the tools and equipment frequently used in chemistry experiments in the laboratory were indicative of common resources accessed by students. Chemistry subjects are generally supported by laboratory experiments. Although there is no laboratory in every primary and secondary school in Türkiye, teachers try to provide science education to children using their own resources. Having access to simple tools and equipment may have led teachers to conduct more experiments in chemistry. When the 2024 science curriculum in Türkiye is examined, themes related to all sub-branches of science are evident: scientific process skills, self-regulation, communication, and social emotional learning skills such as cooperation, are at the forefront rather than the emphasis on science fields. Taber (2014) reported that chemistry has an abstract and challenging nature and that enrichment based on complex, open-ended, task-oriented laboratory practices would be beneficial for gifted children.

Gifted students stated that differentiated activities were rarely used in regular science classes. However, they considered enrichment activities to be sufficient in BILSEM applications. Watters and Diezmann (2003) stated that science teachers rarely provided gifted students with enrichment opportunities within formal school structures. They reported that school problems were disconnected from world problems. Teachers' epistemological beliefs and the notable tendency towards rote learning, based on discipline had an effect on many students, which produced quite negative attitudes towards science (Watters & Diezmann, 2003). This finding aligns with most studies indicating that differentiation was rarely used for gifted students in regular classes (Archambault et al., 1993; Bernal, 2003; Westberg et al., 1993). VanTassel-Baska et al. (2021) found that gifted students did not generally benefit sufficiently from differentiation practices; middle school classes were less effective than elementary or high schools in using differentiation for gifted students. In 38 studies on differentiation, Nicholas et al. (2024) found that gifted, high-ability, high-performance students preferred interdisciplinary or intercurricular integrated learning experiences, and disciplinary areas such as engineering, science, analogies, and scales. The reason for this finding in the study may be that teachers' knowledge and practices regarding differentiation are insufficient, and their self-efficacy levels for differentiation are potentially low. Caldwell (2012) developed a regression model on differentiated instruction, attitudes, and self-efficacy in the education of gifted students in regular classes, revealing that these three variables interact. This study found that teacher self-efficacy was a more important factor than attitudes toward gifted students in voluntarily differentiating education for gifted students (Caldwell, 2012).

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The majority of gifted students stated that they used observation, prediction, and online research during experiments. Gifted students generally reported that they followed the order in the textbook and that the activities were teacher-centered. However, students stated that there were various problems in science classes such as missing materials, completing tasks early, getting bored, experiments failing, lack of content knowledge among teachers, noise, and discipline problems in the classroom. According to gifted students, insufficient technical materials, technical malfunctions, and unintended accidents are among the problems related to the course. Kruit et al. (2018) emphasized that suitable environments and materials should be available for the successful application of the experimental method in science, and that it is important to have qualified teachers who follow scientific practices. VanTassel-Baska (2021) stated that the lack of emphasis on visual arts, mechanical arts, and technology for gifted students led to boredom in a classroom full of words. Yang and Park (2015) found that gifted students perceived that experimental design in science classes was teacher-centered, textbook-focused, and not student-centered. An examination of the relevant literature shows that lessons taught in fields such as science and mathematics without differentiation are boring for students, resulting in tasks being completed early (Hofer, 2023; Groman, 2023; VanTassel-Baska, & Brown, 2021). Johnsen (2023) reported that educators need to learn how to create inclusive, effective learning environments that are sensitive, engaging and encourage interaction. Jeong and Kang (2022) have shown that if the interests of gifted students are supported in effective science teaching, these students develop better explanation and understanding skills in science subjects. An effective learning environment is not static, but a dynamic area that addresses the interests, strengths and needs of each student. The findings obtained from the study may include reasons such as teachers not applying preventive classroom management, a lack of knowledge on this subject and the unmet needs of gifted students in science. In Türkiye, studies are ongoing to provide teachers with an inclusive education approach and a differentiated philosophy that integrates with the National Education Maarif Model (2023).

Gifted students' expectations of science classes include student-centered experiments based on active learning, along with out-of-school learning environments to develop cognitive and social skills. In addition, integrating technology into classes and using innovative methods and techniques are among other expectations. In science education, issues such as making a transition from theory to practice, designing student-centered experiments, working with real-life problems, and using different methods and techniques supported by technology are considered essential. Nacaroglu and Bektas (2023) revealed that the flipped classroom model for gifted students in science classes positively affected students' self-regulated learning and academic success. O'Grady-Jones and Grant (2023) revealed that Collaborative Game Design-Based Learning on 21st Century Skills had a positive effect on gifted students' problem-solving, creativity, and collaboration. Yoon et al. (2020) emphasized the importance of developing enrichment programs to foster gifted and talented students' strong leadership skills, scientific knowledge, and articulate visions for the future. Sak and Ayas (2020) found that gifted students produced more creative hypotheses about scientific facts, designed more effective experiments to test hypotheses, and evaluated scientific evidence more effectively after participating in The Education Programs for Talented Students (EPTS). Ozdeniz et al. (2023) found that blended learning applications in science classes improved gifted students' scientific reasoning and scientific process skills.

Conclusions and Implications

The findings of this study reveal the perceptions of gifted students in primary school towards science lessons. Gifted students generally associate the concept of science with elements such as experiment, scientific method, laboratory and microscope, and are particularly interested in astronomy, earth sciences and chemistry. However, it was found that interest in other areas of science, such as biology, was quite limited. This situation shows that the scope of science should be expanded and focus more on areas such as biology. The reason for this finding may be that schools in the southeastern Türkiye are not equipped with laboratories that include microscope facilities. In addition, these students do not adequately establish the relationship between science concepts and technology. This situation indicates a need to enhance the integration of science education with technology, particularly through interdisciplinary applications such as STEM.

Gifted students stated that they generally encountered teacher-centered practices in science lessons and that technology and student-centered learning methods were insufficient. The lack of technology-based practices such as STEM, robotic coding and engineering negatively diminishes the interest of these students in science lessons and limits their development potential. While the students found the science education they received in BILSEMs more satisfactory, they stated that the practices offered in regular classrooms were not in line with their expectations. In

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science courses, student-centered and active learning-based experiments are important factors that contribute to the development of students' cognitive and social skills. In this context, ensuring the transition from teacher-centered approaches to student-centered approaches improves the quality of the course and increases students' motivation. In addition, increasing technology integration into science lessons, implementing differentiated teaching models and enriching out-of-school learning opportunities play an important role in meeting students' expectations. In order for gifted students attending primary school to achieve the goals expected of science education, it is clear that some revisions should be made in the current curriculum. Inclusion of innovative teaching methods such as flipped classrooms, blended learning, and approaches that develop skills such as problem solving, creativity, and collaboration in science lessons would be an important step to meet the educational needs of these students. In addition, integrating cognitive and non-cognitive elements, such as self-regulation skills, into science education can contribute to students' self-actualization. The implementation of such an educational approach is expected to enable students to participate more actively in learning and may provide a more productive science education experience.

Limitations

Among the limitations of this study is that the participant group was limited to gifted students in a specific region making it difficult to generalize the results to all gifted students. In addition, the exclusive use of interviews was a limitation in data collection. In future studies, the use of observations in science lessons may increase the depth of the findings by providing a more diverse array of data. The evaluations on teaching methods and technology integration in science lessons were based only on students' perceptions, and the perspectives of teachers or school administrators were ignored. Finally, only students' views prevented a definitive assessment of how effective the proposed changes would be in the classroom environment.

Note

Some of the findings in this study were presented at the *8th National Congress on Education of the Gifted* held in Ankara from 2 to 4 November 2023.

Declaration of Interest

The authors declare no competing interest.

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